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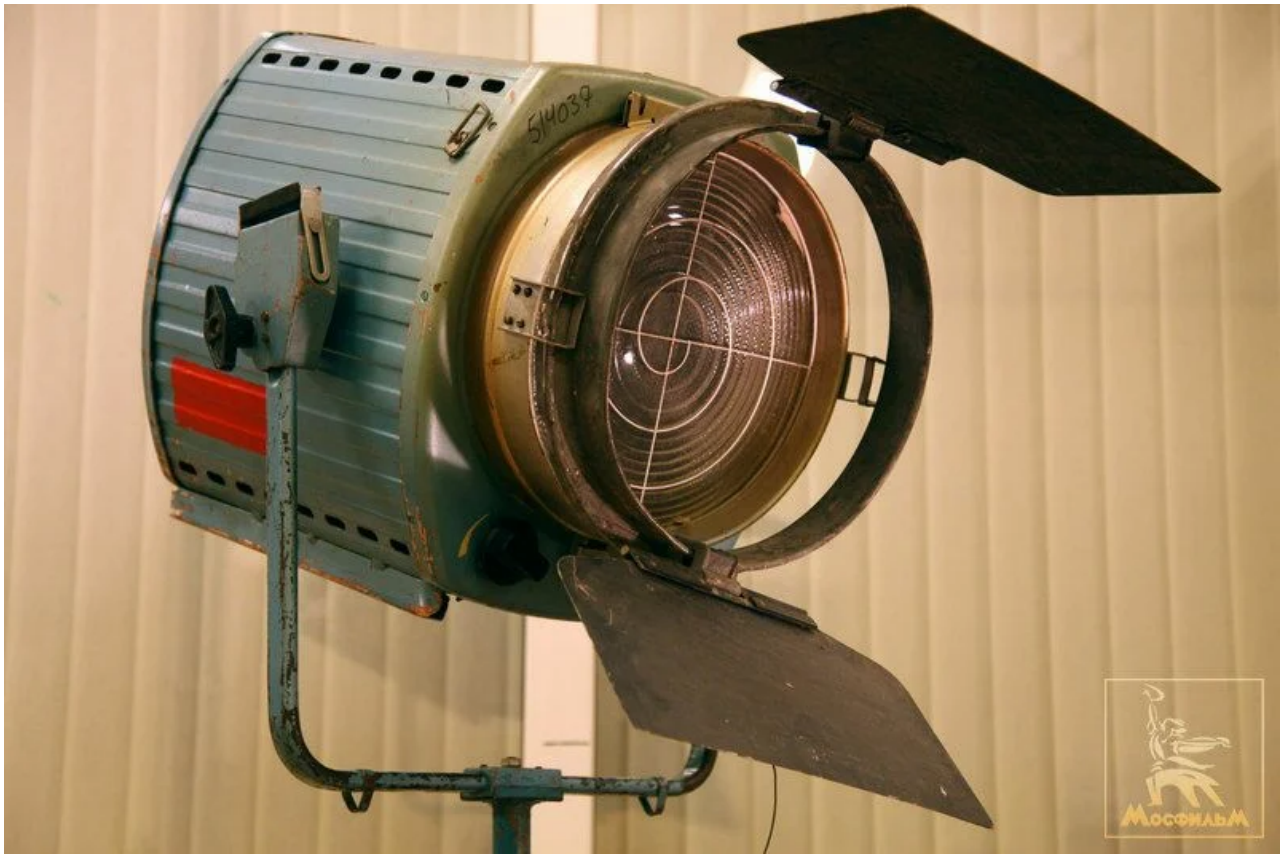
18 min read

80. What kind of lighting device simulated the light of the sun in NASA's "lunar" images?

NASA has officially announced that it cannot make a "lunar spacesuit" until 2023. This turned out to be another confirmation of the fact that in 1969 the actors were wearing fake moon suits, and the entire landing on the moon took place in the pavilion.

And when we begin to reflect on how a part of the lunar landscape was recreated in the pavilion, the question involuntarily arises - what kind of lighting device was used to simulate the light of the sun? It is clear that this should be a very powerful device that illuminates the scene from a distance of at least 100 meters, so that the shadows look parallel and not fan out. What are the **most powerful lighting devices** that existed in film studios in the early 70s? XX century?

It is necessary to immediately exclude incandescent lamps, although in the cinema until recently (somewhere before the early 2000s) lighting devices with incandescent lamps were widely used. For example, the effect of sunlight beating through the window was very often recreated in the pavilion using Zarya 5000 or Zarya 10000 Fresnel-lens floodlights, which respectively had 5,000 and 10,000 W lamps.



Lighting device "Zarya 5000" from the lighting department of "Mosfilm"

Lighting device "Zarya 5000" from the lighting department of "Mosfilm"

Similar devices were in all film studios in the world.

The 10kW lamp was larger than a human head, generated a lot of heat, so the lamp was large and had slots at the top and bottom for ventilation of the interior space and heat removal.

A 10 kW incandescent lamp versus a 100 W household lamp

A 10 kW incandescent lamp versus a 100 W household lamp

Modern 10 kW lamps look like this:


GE
CP 83
240V 10KW
MADE IN JAPAN

ARRI lighting devices are designed for these lamps:

Lighting department of VGIK. There are ARRI appliances on the floor.

Lighting department of VGIK. There are ARRI appliances on the floor.

The actual light radiation in such an incandescent lamp consumed about 6% of the energy consumed (the light output was very low, 25 lm / W). The fact is that most of the emitted radiation was in the invisible infrared zone. The devices gave off a lot of heat and very little light. If the shift in the pavilion ended, for example, at 10 o'clock in the evening, then the lighting device was turned off at 21-20, 40 minutes before the end of the shift. It took 40 minutes for fire safety for the device to cool down.

The light color of the incandescent lamp is warm yellow, and in order to turn it into an analogue of sunlight, a blue compensation filter had to be attached to the device, which turned the color temperature of 2800 K into 5500 K. This blue filter reduced the luminous flux by 3.5 times. Thus, a very ineffective light source was obtained - it consumed a lot of energy, and gave out very little light (here you can draw an analogy with an electric fireplace). With the blue filter, it turned out that only 2% of the energy consumed went to illuminating the object, the rest was absorbed by the filter, by the walls of the lighting device (after all, the lamp was shining in all directions) and simply turned into heat. Therefore, such a device was used to create light effects, for example, the effect of sunlight in the form of a window siding on a wall.

The effect of sunlight on the wall was created in the pavilion using a spotlight

The effect of sunlight on the wall was created in the pavilion using a spotlight

There were, of course, more powerful incandescent lamps, 30 kW each.

САМАЯ МОЩНАЯ ЛАМПА В СССР

Московский электроламповый завод изготовил две лампы мощностью по 30 киловатт каждая. Это самые мощные в Советском Союзе лампы. Сила света каждой из них достигает 110 тысяч свечей. Одной такой лампы достаточно, чтобы осветить Красную площадь в Москве.

Длина новой лампы составляет 88 *см*, а ее вольфрамовая нить весит 136 *г*. Из этого вольфрама можно было бы изготовить 17 тысяч обычных ламп (по 25 ватт).

Note from the journal "Technology for Youth"

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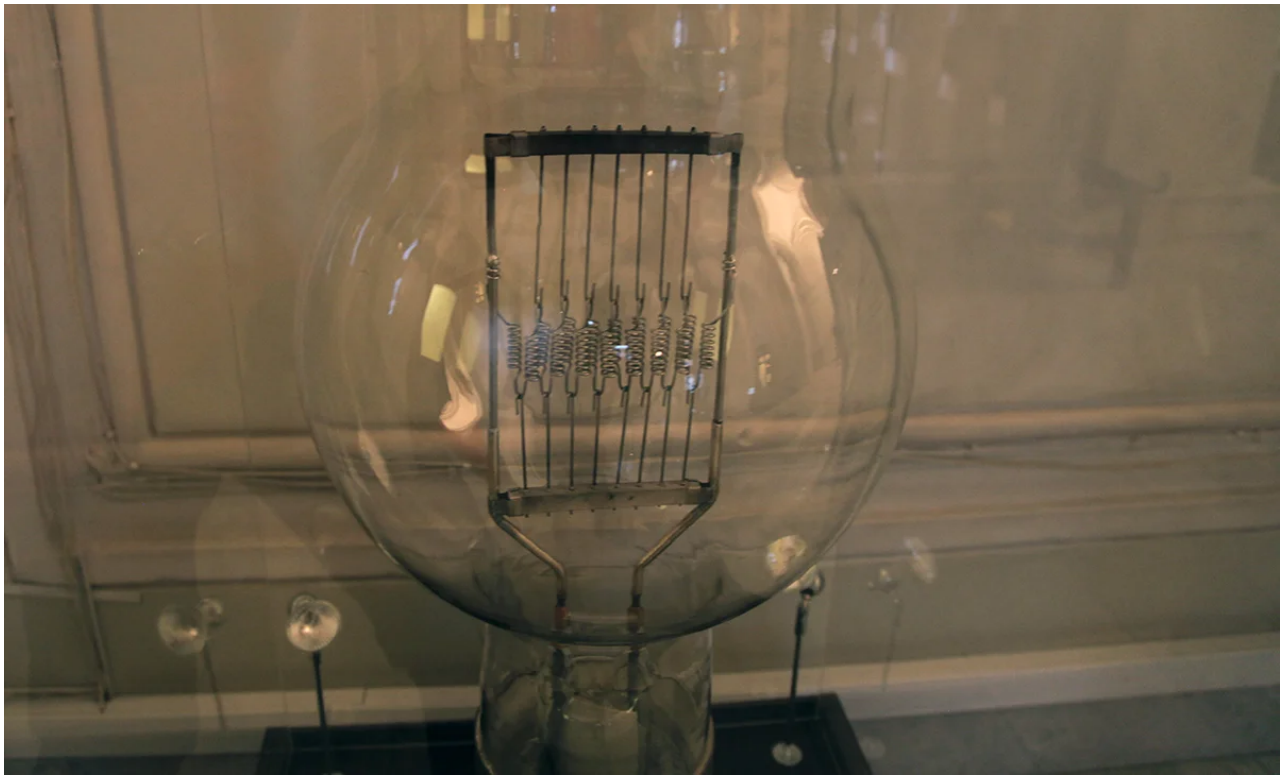
One such lamp is now in the Polytechnic Museum of Moscow as a unique exhibit. Here I took some photos.

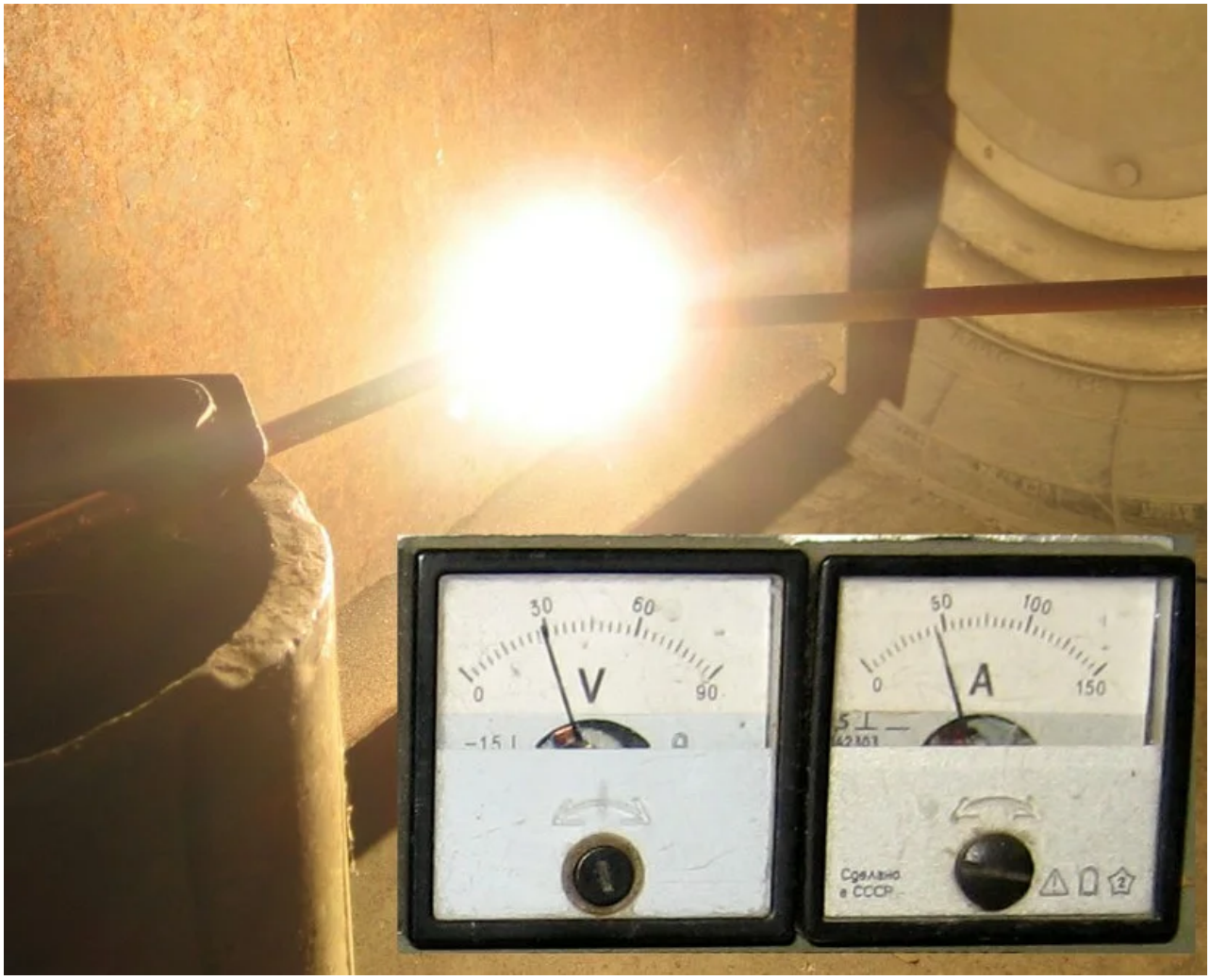
Incandescent lamp with a power of 30 kW at the Polytechnic Museum of Moscow

Incandescent lamp with a power of 30 kW at the Polytechnic Museum of Moscow



But the most powerful light sources used in filmmaking are not incandescent bulbs, they are intense arcs (DIGs).

For the first time an electric arc was obtained by the Russian scientist V.V. Petrov in 1802. To ignite the arc, coals with different electric charges (anode and cathode) need to be brought together until they touch. As a result, individual sections of the cathode are heated. When the cathode heats up, the coals are diluted, and an arc arises between them. Many have seen an electric arc, for example, when welding metals.

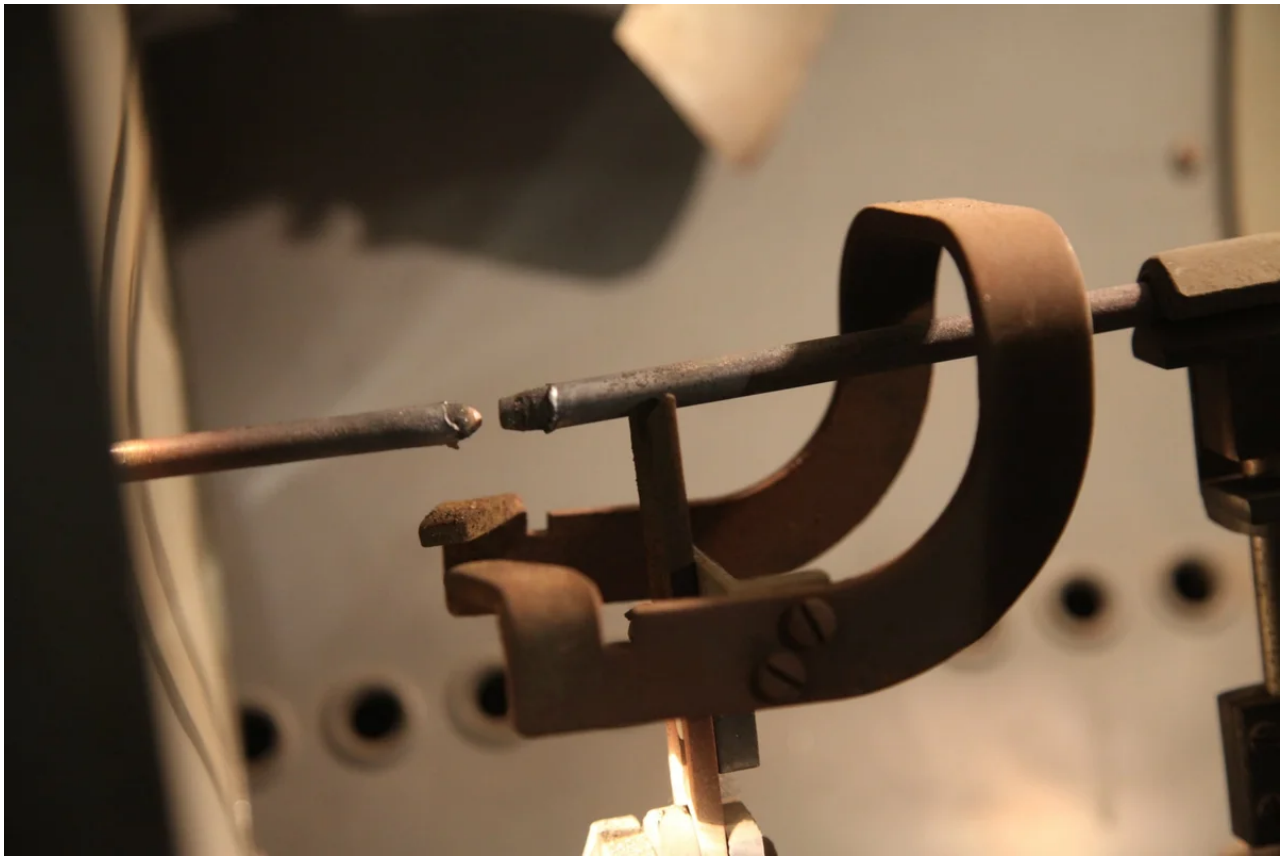


Electric arc between two electrodes.

Electric arc between two electrodes.

The highest luminous flux is obtained when the arc is supplied with direct current.

For a long time, movie theaters have also used an electric arc between two electrodes as a light source in a movie projector.



The lighting part of the theatrical cinema projector consists of two electrodes.

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The main source of radiation in the electric arc is the crater of positive coal. Inside it, along the axis, a cylindrical hole is drilled, which is filled with a wick - a pressed mass consisting of a mixture of soot and oxide of rare earth metals (thorium, cerium, lanthanum). The negative electrode (carbon) is made from a solid material without a wick.

Coal filming white flame for DIG

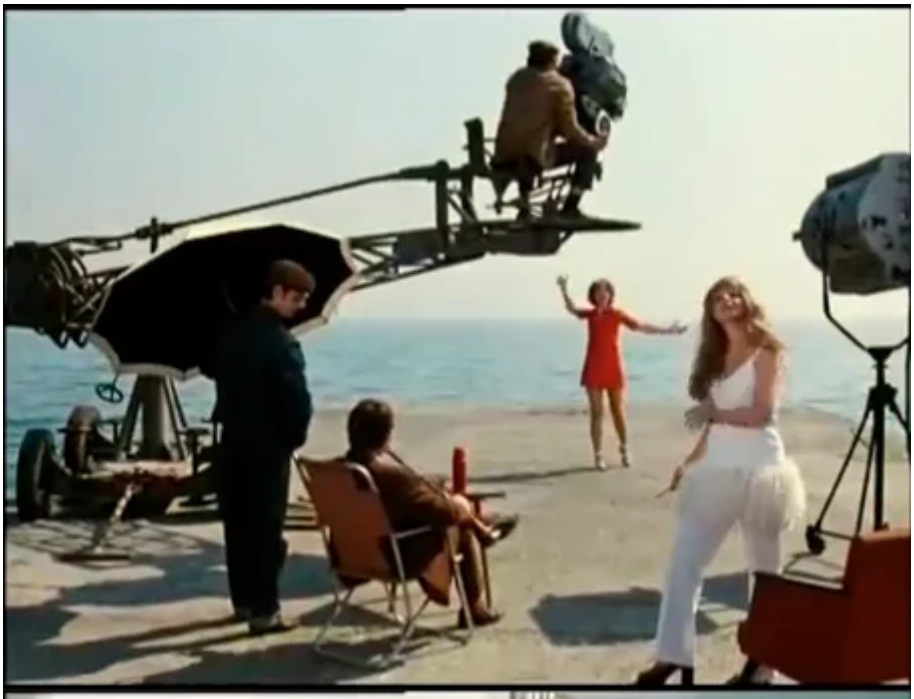
Coal filming white flame for DIG

The color of the arc radiation is quite close to sunlight, so when shooting on location, an additional light filter is not required. The intense burning arc emits much less in the infrared zone, converts most of the energy into visible light, therefore its light output is 2-2.5 times higher (50-60 lm / W) than that of an incandescent lamp (25 lm / W).

The low light output of the incandescent lamp and the need to use a blue compensation filter to simulate the spectrum of sunlight radiation, speaks of the uncompetitiveness of such a lighting device. Firstly, the light output per watt of energy consumed is 2-2.5 times less, and secondly, an additional decrease in the luminous flux by 3.5 times due to the light filter. In total, to replace **one** DIG, 8-9 devices of similar power with an incandescent lamp are required.

Therefore, we can state quite unequivocally that no incandescent floodlights were used in the scenes of the Americans staying on the moon.

During the filming of films, DIGs were used exclusively on location. We can see these devices, for example, in the 1973 film "Ivan Vasilyevich Changes His Profession", during the performance of the song "The January Blizzard is Rings."



The film "Ivan Vasilievich Changes His Profession". In the frame - KPD-50. In the lower frame, the illuminator twists the charcoal feed knob at the back of the illuminator.

The film "Ivan Vasilievich Changes His Profession". In the frame - KPD-50. In the lower frame, the illuminator twists the charcoal feed knob at the back of the illuminator.

During the operation of the lighting fixture, the charcoal gradually burns out. To supply coal, the device has a small motor, which, with the help of a worm gear, slowly feeds coal forward. Since the coal did not always burn evenly, the illuminator occasionally had to twist a special handle on the back of the lighting fixture in order to bring the coals closer or further away.

In the lower (third) frame from the film "Ivan Vasilyevich Changes His Profession" we can see that the face of the actor M. Pugovkin is also highlighted by the DIG. The actor is in the shadow of an umbrella, his face projected onto the dazzling white buildings in the background. Without additional lighting, the face under the umbrella would be just a silhouette against the backdrop of white buildings. The fact that the backlight exists is easily understood by the reflections in the sunglasses of the illuminator with the umbrella.

In the uppermost frames of the triad, where N. Selezneva sings a song, DIG is also used, it illuminates the shadow side of the face, in the eyes we see a glint from a lighting device. In the background - a bright sky and a bright white steamer. Without this highlight, the shadow on the face would be very contrasting and dark.

The luminous point of the DIG is reflected in the eyes. Highlights are used to soften shadows.

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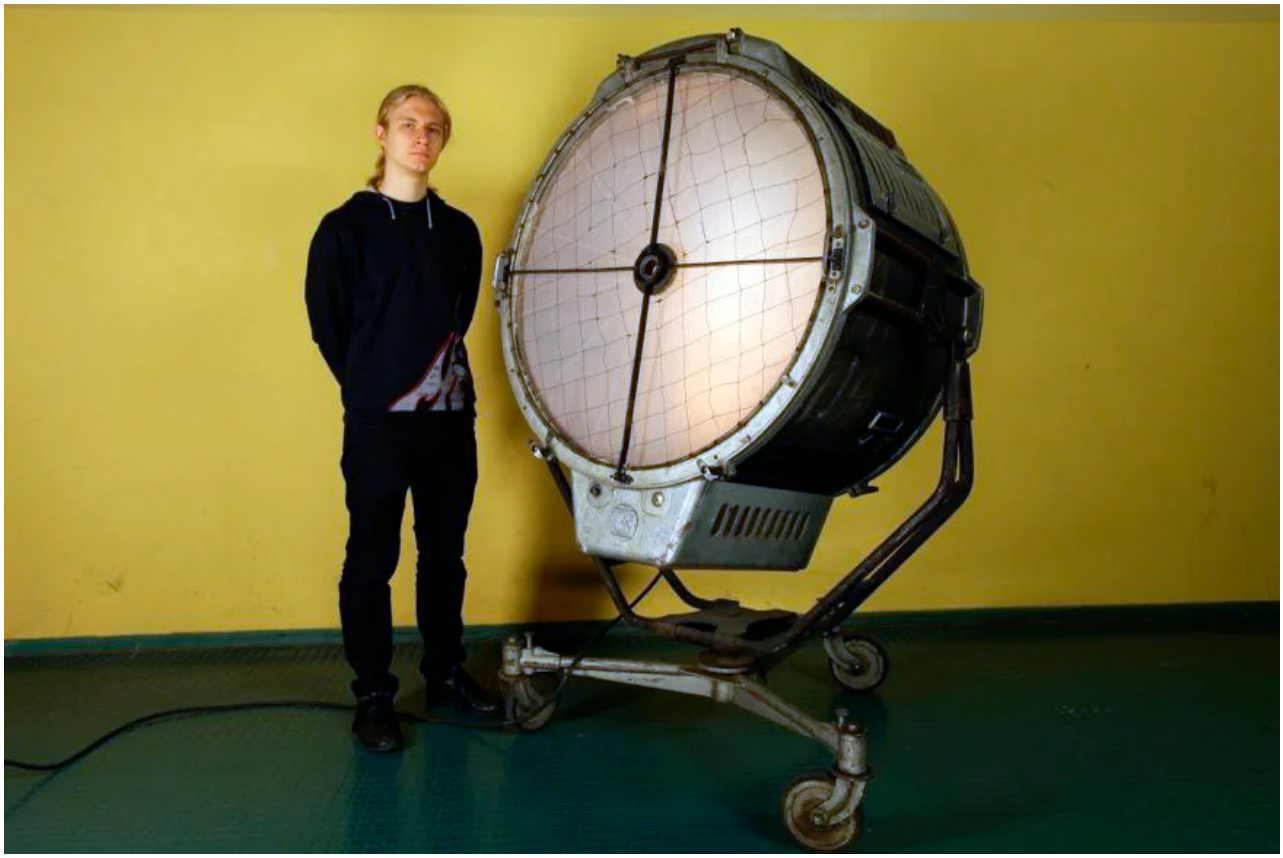
They tried not to put the actors on the spot facing the sunlight. Indeed, in this case, the actors have to squint strongly, unpleasant shadows appear under the eyes from the overhead light. In the next photo, you can see both the narrowed eyes and a line of shadow on the eyes. And we also placed this photo so that you can see the handles for moving coal on the back of the DIG.

On the back of the device, you can see the handles for moving the coal.

On the back of the device, you can see the handles for moving the coal.

The power consumption of the DIG is 18 kW. It is powered by a direct current network, so it needs a mobile power plant, which is referred to as "lichtvagen" - (German: Licht - light and Wagen - carriage) a mobile diesel generator on a car chassis.

Arc lighting devices with a lens diameter of 50 cm were very popular, but there were devices of a larger size, with a lens diameter of 90 cm ("meter"), KPD-90 and KPD-150 with a power of 27 kW, the mass of which was about 250 kg.



Lighting device KPD-90 (DIG "Metrovik"). Power 16 kW. USSR, 1970s.

Lighting device KPD-90 (DIG "Metrovik"). Power 16 kW. USSR, 1970s.

There is always a spherical focusing mirror inside the arc device.

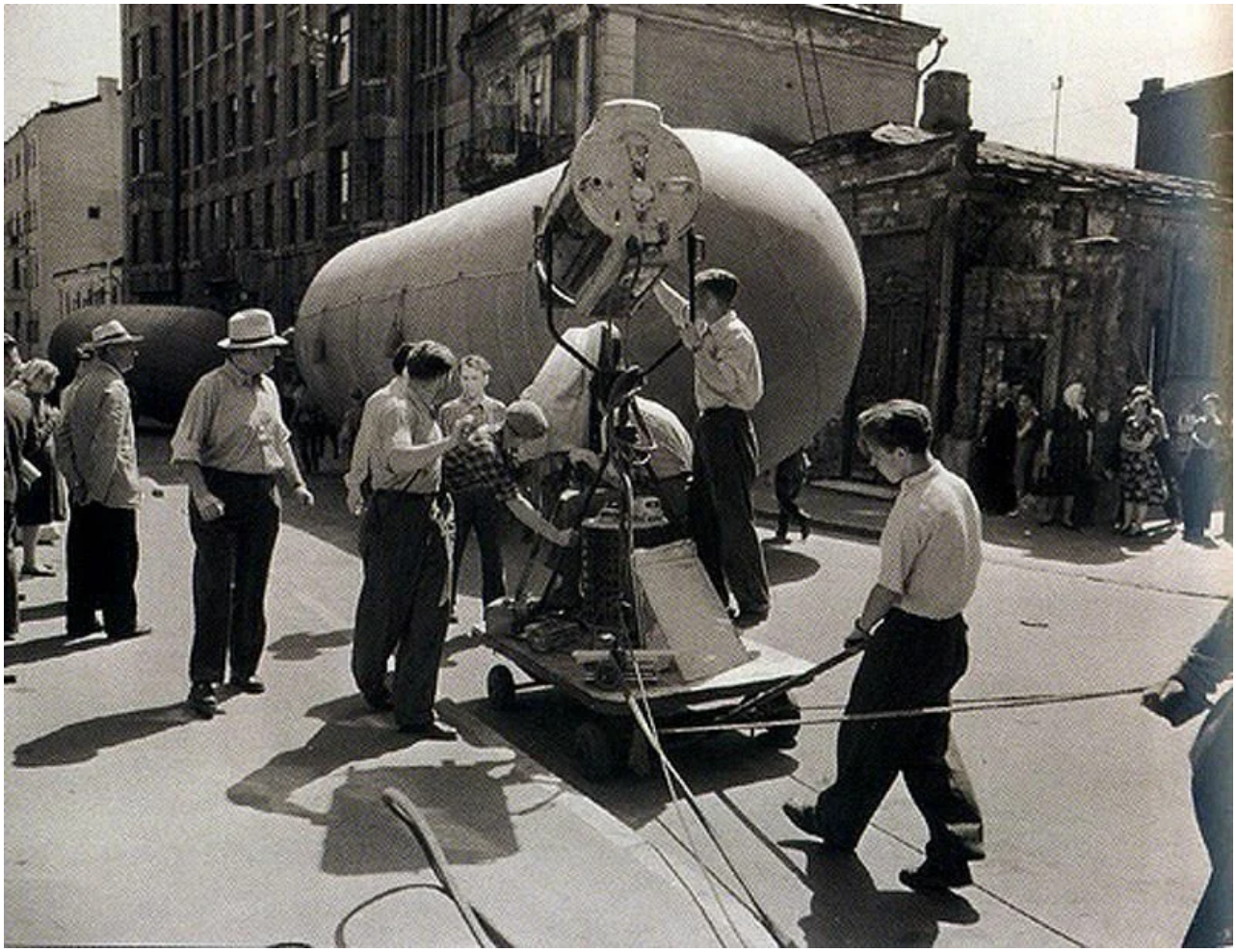
KPD-90 (arc projector), ballast stands next to it in the form of a cylinder.

KPD-90 (arc projector), ballast stands next to it in the form of a cylinder.

KPD-90 on the set

KPD-90 on the set

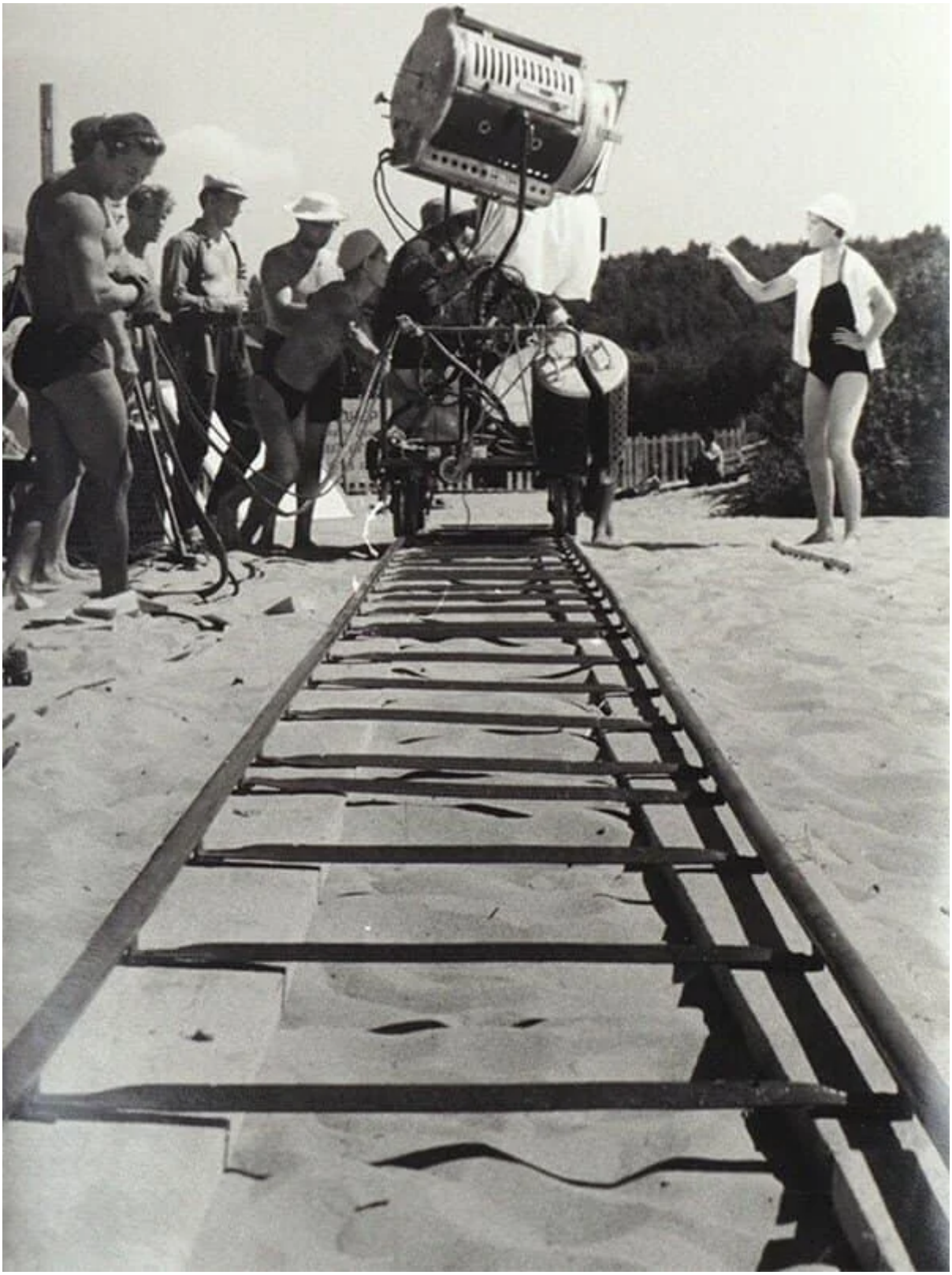
Arc devices were used to illuminate, primarily the shadow side of the actor. Without backlighting, the light on the face turned out to be very contrasting, with dropped shadows.



Illumination of the shadow part of the DIG. There is a ballast - choke under the device.

Illumination of the shadow part of the DIG. There is a ballast - choke under the device.

Here is the working moment of filming the movie "Welcome, or No Unauthorized Entry!" (1964)



And what happened in the frame as a result of the backlight:

Or here's a working moment of the movie "The Diamond Arm". Comments of the cameraman A. Lapshov.

Here's another example: 1944, Maria Montes on the set of the film "Cobra Woman" (USA). DIGami highlights the shadow side.

Working moment of the film "Cobra Woman", 1944, USA.

Working moment of the film "Cobra Woman", 1944, USA.

I specifically emphasize that field lighting is used to soften shadow areas on a sunny day, since in the American Wikipedia you will read a distorted presentation of the use of DIGs in cinema. Wikipedia is an American platform with a pronounced Russophobia, thereforeon the page dedicated to S. Bondarchuk's film "War and Peace" (1965-1967), the authors of the article tried to highlight as many technical shortcomings of the film as

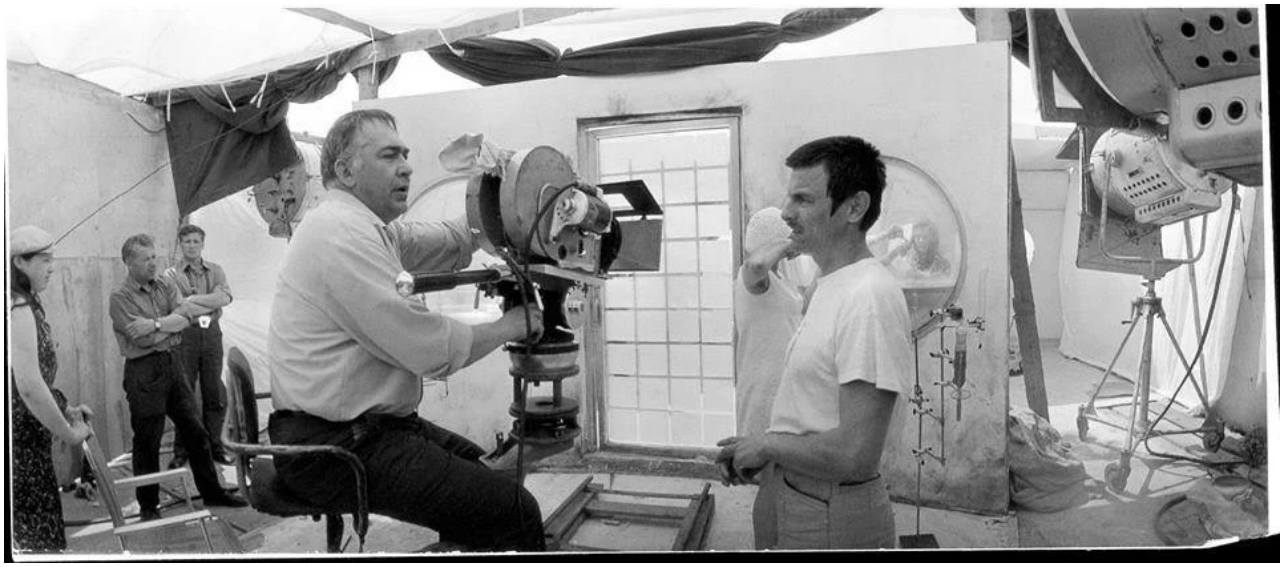
possible and write as many anti-Russian nonsense as possible. That there is only one phrase:

> The poor sensitivity of the film led to the fact that the set had to be additionally illuminated with spotlights, even during the day, in natural light. Because of this, the work on the painting took so long.

Sergey Bondarchuk on the set of the film "War and Peace"

Sergey Bondarchuk on the set of the film "War and Peace"

DIGs were also used inside the pavilions. Here, for example, is the working moment of filming the film "Solaris" (directed by A. Tarkovsky, 1972), where you can see installed DIGs on the right and left.



Film "Solaris". Behind the camera - cameraman Vadim Yusov, right - director Andrei Tarkovsky.

Film "Solaris". Behind the camera - cameraman Vadim Yusov, right - director Andrei Tarkovsky.

But this was not welcome. When burning, the coals hissed, and therefore when shooting it was impossible to record a clean soundtrack. And, in addition, not very pleasant smells were emitted during combustion.

Now let's move on to the most powerful lighting fixtures that have been developed in the United States. In the USA, anti-aircraft searchlights with a mirror diameter of 150 cm were mass-produced for anti-aircraft and marine installations.

US anti-aircraft searchlight complete with power generator.

US anti-aircraft searchlight complete with power generator.

I would like to draw your attention to the fact that the glass on the device is not solid, but split into several narrow sectors. If the glass were solid, then due to uneven heating in the center and along the edges during the operation of the lighting device, the thick glass

would certainly crack. Therefore, in order to remove internal stresses when heating the glass, it was previously divided into independent sectors.

Similar mobile anti-aircraft searchlights with a parabolic mirror diameter of 150 cm were produced in the USSR in 1938-1942. They were installed on a ZIS-12 car and, first of all, were intended to search, detect, illuminate and track enemy aircraft.

Automotive searchlight station Z-15-4B on a ZIS-12 vehicle.

Automotive searchlight station Z-15-4B on a ZIS-12 vehicle.

The luminous flux of the spotlight of the station Z-15-4B could be picked up in the night sky by an aircraft at a distance of up to 9-12 km. The light source was an electric arc lamp with two carbon electrodes. The length of the positive electrode was about 60 cm, the duration of the burning of the electrodes was 75 minutes, after which it was necessary to replace the burnt coals. The device could be powered from a stationary current source, or from a mobile generator of electricity with a power of 20 kW, and the power consumption of the lamp itself was 4 kW.

This anti-aircraft searchlight station of the Z-15-4B type can be seen, for example, in The Air Defense Forces Museum in Balashikha, Moscow Region .

Anti-aircraft searchlight station of the Z-15-4B type.

Anti-aircraft searchlight station of the Z-15-4B type.

We are talking about 150-centimeter anti-aircraft searchlights, since they were used in lunar missions. We see these spotlights everywhere. At the beginning of the film "For all mankind" (1989 film) we see the spotlights turn on.

The right frame in the next photo is just 150-centimeter anti-aircraft searchlights, which illuminate the rocket standing on the launch pad.

150 cm spotlight (left) and still frame (right) from the film "For All Humanity"

150 cm spotlight (left) and still frame (right) from the film "For All Humanity"

Taking into account the fact that the height of the rocket is 110 meters, and we can see the rays of light, we can estimate from what distance the searchlights are shining - this is approximately 150-200 meters.

The booster on the launch pad is illuminated by anti-aircraft searchlights

The booster on the launch pad is illuminated by anti-aircraft searchlights

We see the same searchlights in the pavilion, during the training of astronauts. These searchlights in the photographs of "Apollo 11" were pointed out by A. Panov ("The Non-Walker") 10 years ago.

Apollo 11 crew training. In the depths - an anti-aircraft searchlight.

Apollo 11 crew training. In the depths - an anti-aircraft searchlight.

Training in the pavilion. In the back of the hall there is an anti-aircraft searchlight.

Training in the pavilion. In the back of the hall there is an anti-aircraft searchlight.

There is a parameter that allows you to estimate the distance to the lighting device on the so-called moon images - this is the blur of the shadow. I mean to simulate blurring the shadow on a sunny day. The fact is that from a physical point of view, the sun is not a point source of light. We perceive it as a luminous disk with an angular size of 0.5 °. Because of this circumstance, a penumbra contour appears around the main shadow as the distance from the subject increases.

At the base of the tree, the shadow is sharp, but as the distance from the object to the shadow increases, blurring, partial shade is observed.

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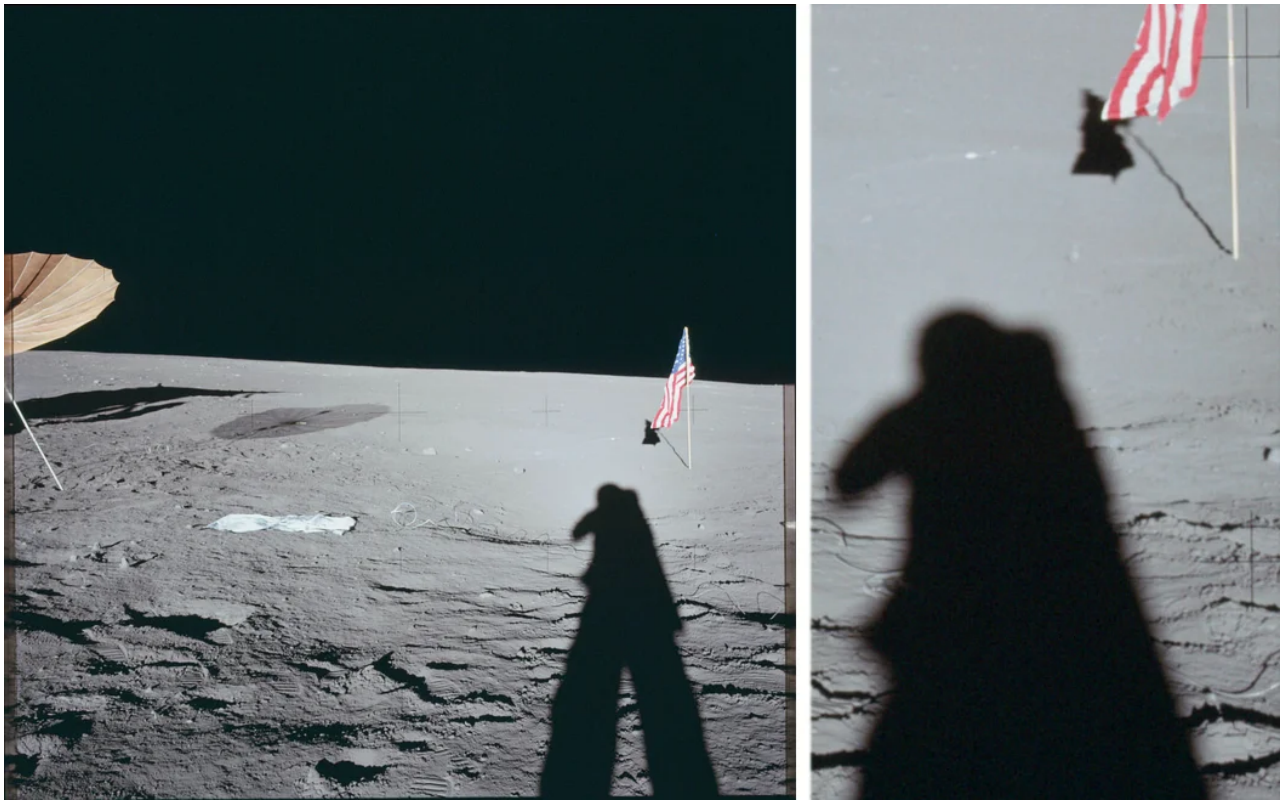
And in the "moon" shots we see the blur of the shadow along the contour.

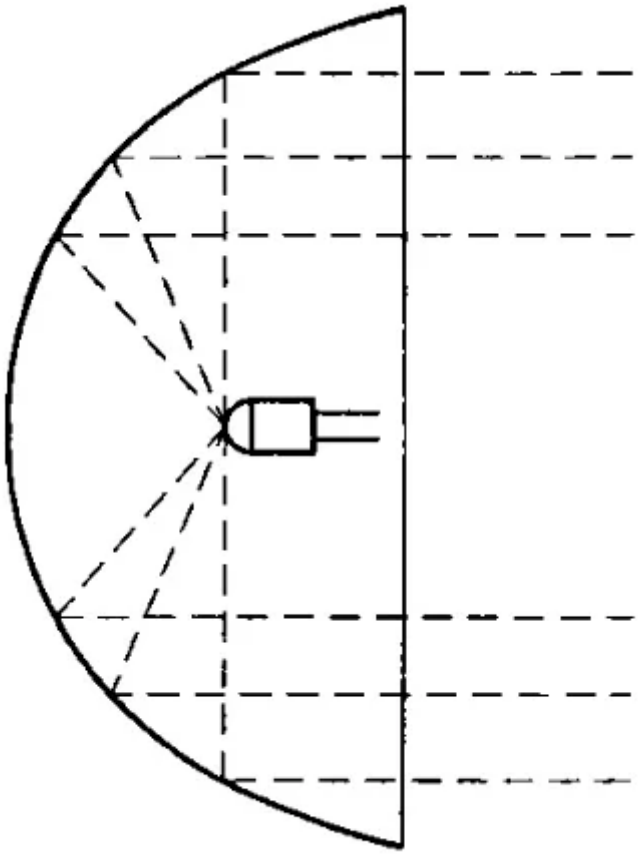


The astronaut's shadow blurred with distance.

The astronaut's shadow blurred with distance.

To get a "natural" blur of the shadow, as if on a sunny day, the luminous body of the lighting fixture must be observed at the same angle as the Sun, i.e. half a degree.

Since the zenith projector uses a parabolic mirror with a diameter of one and a half meters to obtain a narrow beam of light, it is easy to calculate that this luminous object needs to be removed by 171 meters so that it can be seen with the same angular size as the Sun.



Using a parabolic reflector to concentrate radiation.

Using a parabolic reflector to concentrate radiation.

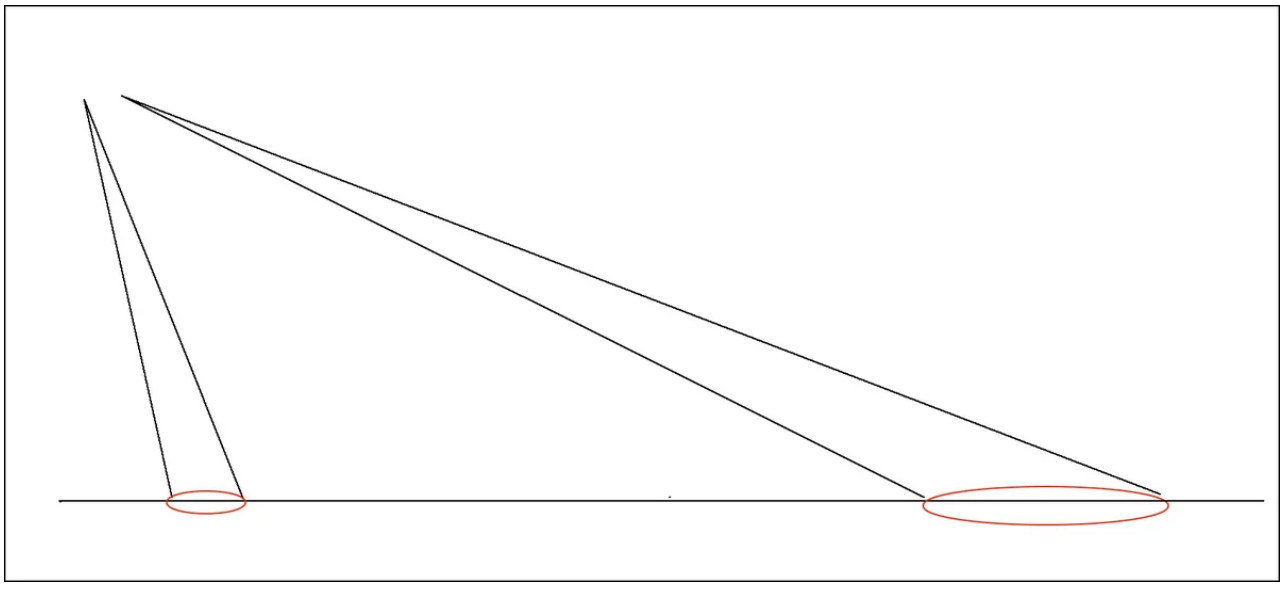
Thus, we can say with a high degree of confidence that the anti-aircraft searchlight, imitating the light of the Sun, was enough to be removed by about 170 meters in order to get the blur of the shadow in the pavilion the same as on a real sunny day.

These anti-aircraft searchlights from a distance of 170 meters create sufficient illumination on the site to make filming, but these searchlights have a very narrow angle of divergence, about 4 °.

Anti-aircraft searchlights over Gibraltar during a drill on November 20, 1942.

Anti-aircraft searchlights over Gibraltar during a drill on November 20, 1942.

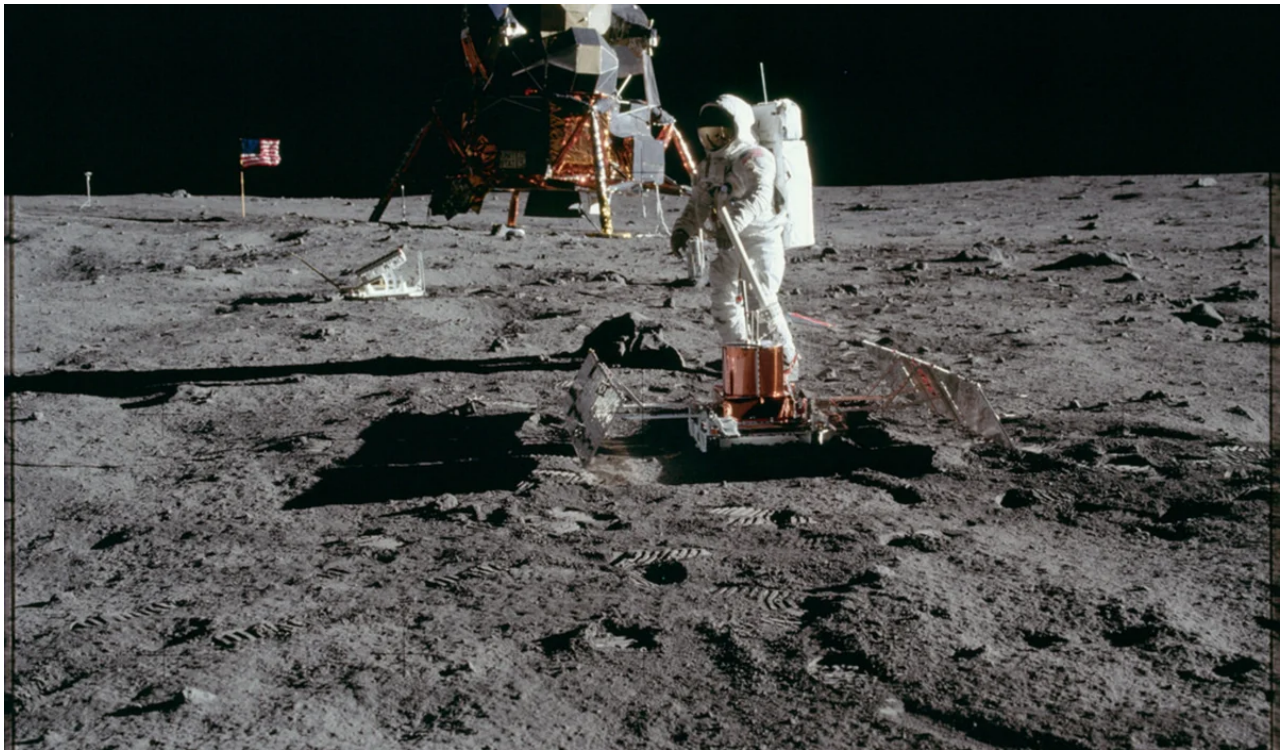
To illuminate the largest area with one device, you should illuminate the surface with a "grazing" light.



Change in the area of the light spot at different angles of incidence of the rays.

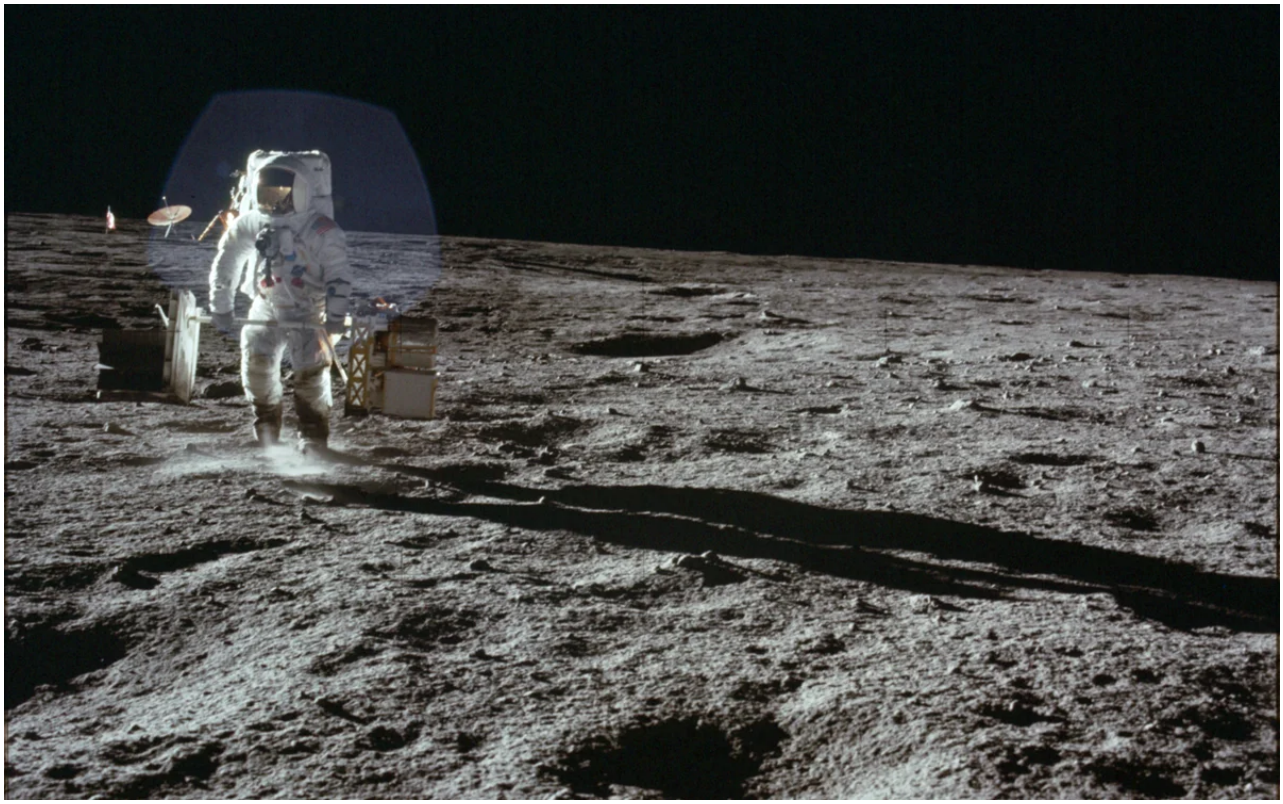
Change in the area of the light spot at different angles of incidence of the rays.

At a large angle of incidence (measured from the perpendicular to the surface), the luminous flux from the spotlight is distributed in the form of a highly elongated horizontal ellipse of great length. From the point of view of filmmaking, the most convenient option is shooting with a low "sun" over the "lunar" horizon, for example, as we see in the photo albums "Apollo 11" and "Apollo 12".



Typical Apollo 11 photo with long shadows.

Typical Apollo 11 photo with long shadows.



Typical Apollo 12 photo with long shadows.

Typical Apollo 12 photo with long shadows.

When the sun rises above the horizon at 18 ° degrees (this is the height of the sun declared by NASA in the Apollo 11 and Apollo 12 missions at the time of landing), the shadow is 3 times longer than the height (height) of the astronaut. When the anti-aircraft searchlight is located at such an angle, the light spot will lie in an ellipse with a major semiaxis length of 40 meters. That is, one anti-aircraft searchlight from a distance of 170 meters will more or less uniformly illuminate an area 40 meters wide. This is quite enough to shoot general shots. And it also allows for horizontal left-right panning while maintaining the feeling of a single light source.

Defenders of NASA explain the fact of the "low sun" by the fact that in the middle of the day the regolith heats up above + 120 ° C (the middle of the lunar day occurs in about 7 Earth days, and the total lunar day lasts 29 Earth days), but in the morning, when the sun is low rose above the lunar horizon, the lunar soil allegedly had not yet had time to heat up to a high temperature.

In fact, the side of the soil facing the sun heats up to a high temperature just a few hours after sunrise. Therefore, we believe that the true reason for the low sun in the "lunar"

images lies precisely in the fact that with one powerful device, uniformly illuminate the largest area.

Probably, as you read the article, you had questions: how to mount such a bulky lighting device under the ceiling of the pavilion and how to quickly change the coals in it during the shooting day (one coal burns for a maximum of 75 minutes)? And what size should the pavilion be so that the lighting fixture can be moved 170 meters away in it?

We will try to answer these technological questions in the next article: "How many lighting devices do you need to create the effect of light from the sun in the pavilion?"

PS For those who are interested in the variety of lighting devices in the cinema, I recommend reading article by cinematographer Dmitry Masurenkov , a brief overview of the use of spotlights in the filming process.

- Cameraman L. Konovalov was with you. Until next time!

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